EXAMINING THE OPPORTUNITIES OF THE METAVERSE AND GAMIFICATION IN EDUCATION: benefits, and constraints

EXAMINANDO AS OPORTUNIDADES DO METAVERSO E GAMIFICAÇÃO NA EDUCAÇÃO: benefícios e limites

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ABSTRACT

The metaverse is a technology that has great potential to transform the field of education. Specifically, the use of gamification in the metaverse offers a promising paradigm for educational purposes. To investigate the current perspectives on the potential of the metaverse in education, we conducted a literature review that focused on its advantages and limitations. To do this end, we started a specialized search in the main academic repositories, from an initial sample of 50 academic articles published in the last 5 years, 25 of them were evaluated, meeting the proposed inclusion and exclusion criteria. Our analysis revealed that the metaverse has the potential to provide new opportunities for interactive and immersive learning experiences, and gamification in the metaverse may be incorporated to improve student motivation, which may as well lead to more effective learning and better long-term knowledge retention. However, we also identified key challenges that must be addressed, such as privacy concerns and potential interference between AI and teachers. These challenges may hinder the successful implementation of the metaverse in education. Our findings highlight the need for further research to fully understand and address these challenges to ensure the successful adoption of the metaverse in education.

Keywords: Metaverse. Education. Gamification. Online education. Innovation.

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RESUMO

O metaverso é uma tecnologia com grande potencial para transformar o campo da educação. Especificamente, a utilização da gamificação no metaverso oferece um paradigma promissor para fins educacionais. Para investigar as perspetivas atuais sobre o potencial do metaverso na educação, realizamos uma revisão da literatura que se concentrou nas suas vantagens e limitações. Para isso, iniciamos uma pesquisa especializada nos principais repositórios acadêmicos: Web of Science (WOS), Scopus, Redalyc e SciELO. Posteriormente, de uma amostra inicial de 50 artigos acadêmicos publicados nos últimos 5 anos, avaliaram-se 25 deles, atendendo aos critérios de inclusão e exclusão propostos. Nossa análise revelou que o metaverso tem o potencial de aumentar o envolvimento dos alunos e proporcionar novas oportunidades para experiências de aprendizagem interativas e imersivas. No entanto, também identificamos desafios-chave que devem ser abordados, como preocupações com a privacidade e possíveis interferências entre a inteligência artificial e os professores. Esses desafios podem dificultar a implementação bem-sucedida do metaverso na educação. Nossas descobertas destacam a necessidade de mais pesquisas para compreender e abordar completamente esses desafios, garantindo a adoção bem-sucedida do metaverso na educação.

Palavras-chave: Metaverso. Educação. Gamificação. Educação online. Inovação.

INTRODUCTION

In 2007, the Acceleration Studies Foundation defined the metaverse as the fusion of physically enhanced reality and a persistent virtual space. This vision emphasizes the synergy between the tangible and the virtual, creating an environment where interconnection redefines shared experiences, transcending the limitations of both domains (Smart et al., 2007). These environments, known as metaverses, are not just static digital locations; they are whole digital worlds that transcend physical reality in terms of space and time, and change and evolve as the dynamic of the real world does (Park & Kim, 2022).

The concept of the metaverse refers to a shared and immersive virtual world characterized by a three-dimensional space in which users can interact with each other and with the environment similarly as they would in the real world (Shen, 2022; Felip, 2023). The term metaverse dates to 1992 when the scientist and science fiction writer Neal Stephenson wrote the book Snow Crash, where he describes a virtual world called metaverse. However, the first virtual world platform, Habitat, was created in 1989 and counted with a 2D interface. A second wave of social VR systems was born in the 1990s and 2000s, with the platforms Traveler, Croquet, ActiveWorlds, There, Blue Mars, Second Life, and Open Simulator. A third generation of VR environments offering sensory immersion includes Decentraland, Virbela, Spatial, and Sansar (Mystakidis, 2019). Initially, the first generation of the metaverse was conceived as the 3D Internet or Web 3.0. The second generation of the metaverse is currently under construction, where social, immersive VR platforms will be compatible with massively multiplayer online video games, open game worlds, and AR collaborative spaces (Mystakidis, 2019). These environments may be partially or completely virtual.

The use of AR in real-world environments is an example of a partially virtual metaverse; a VR system would be considered a completely virtual metaverse (Avila, 2017). But a metaverse is much more than just AR or VR, as it is widely believed (Park & Kim, 2022),

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though they enable immersive experiences and are used to display virtual resources, such as images, texts, or characters. A metaverse may include AR or VR aspects, such as the need to use Microsoft HoloLens for AR or Oculus Riff for VR. Additionally, artificial intelligence (AI) is crucial to creating and maintaining the rules and restrictions that regulate behavior within a metaverse, enabling a coherent and realistic user experience. But what best differentiates a metaverse from traditional AR or VR are three main characteristics: they are: first, shared (enables interaction in a virtual world in real-time); second, persistent (allows users to create, experiment, and save virtual experiences that remain online); and, third, decentralized (decentralized technologies, such as blockchain are necessary to guarantee that economic transactions take place safely and that the registry of personal property is not modified by others (Min & Cai, 2022).

Metaverses have been identified as the next stage of social interaction, understood as constructed universes in which individuals can live following the rules set up by the creator, where virtuality and reality coexist and coevolve, and where social, economic, and cultural activities take place (Kye et al., 2021). Real individuals or virtual characters may be friends in the metaverse (Márquez et al., 2020; Kye et al., 2021), and individuals can interact socially by keeping conversations, working together on projects, playing games, and learning from their successes and mistakes (Jovanovic & Milosavljevic, 2022; Park & Kim, 2022). Like in the real world, there can be numerous types of activities or events in the metaverse, such as political events, natural disasters, or economic activity (Márquez et al., 2020).

Given their characteristics, metaverses constitute a perfect example of how technology can expand human perspectives and create new opportunities for an infinity of applications, including educational purposes. For instance, when used as a tool in online education, metaverses enable students to experiment an immersive 3D environment. This could include simulations, virtual field trips, and collaborative projects that require students to work together in a shared space (Chen, 2022). Another potential application of the metaverse is in education, in order to create personalized learning environments that adapt to the needs and preferences of individual learners, in other words an AI-powered virtual tutor can adapt the curriculum to match the student's learning pace, interests, and abilities (Hurtado, et al., 2022, Díaz et al., 2020).

For example, a Medicine student could practice surgeries virtually before practicing in real life, or in History student could explore virtual reconstructions of historical sites to learn about the culture of ancient civilizations. In a metaverse, digital identities can be created for educators, students, administrators, and other interested parties, providing formal and informal learning environments. These spaces also enable teachers and students to work together in the same space. Students may interact with their teachers more dynamically, carry out more practical activities and cooperate in teams in a similar way as in the real world.

Big tech companies and educational institutions are jumping on the online metaverse-based educational wagon and, after Facebook rebranded as Meta in October 2021, the company set up a USD 150 million

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fund to develop a learning ecosystem devoted to education within the metaverse (Park & Kim, 2022). In November 2021, Roblox, the main gaming company in the US, invested USD 10 million in educational games (Hollensen et al., 2022), and the University of Stanford delivered the first class completely provided in VR within the course Virtual People (Hadahzy, 2021). However, it is important to define what metaverse-based education is. Despite the shared aspect, using a VR training system is not enough to consider the methodology as metaverse-based education. It is crucial that the collaborative and social aspects are present in the learning process so that the students can interact with each other and with the content dynamically in a shared virtual environment. Individuals may use different identities to connect in a multi-user virtual reality system, such as Second Life, but if the system cannot offer a persistent reality that enables users to live, which includes working, ownership, learning, interacting, producing, and enjoying, it cannot be considered a metaverse.

Gamification is a digital learning approach that utilizes visual and auditory elements, such as animations, music, or games, to enhance problem-solving skills. It facilitates collaboration and the generation of creative ideas. On the other hand, the metaverse provides a public space where individuals from diverse locations can work together virtually, overcoming physical and cultural barriers. Gamification, when applied in the metaverse, enhances the user experience, making learning more enjoyable and memorable by encouraging problem-solving through game design principles (Afacan, 2023).

Besides all the opportunities the concept of metaverse offers to society, including in the educational field, it is not free from criticism. For instance, the sociologist Silvia Molina (2022) remarks that despite the metaverse renders a certain degree of social interaction (gaming teams), visiting these parallel realities provides users with escapism opportunities beyond mere entertainment to an invented world where everything is controlled by the user and where they can take shelter and isolate from interaction. This raises concerns regarding addiction to the metaverse and its impact on real life. Another problem faced is the possibility of the metaverse becoming a tool for social exclusion, as not all individuals have equal access to the necessary technologies to enter and participate. Other thoughts pertain to privacy and security issues, as users share personal information online, or the potential of the metaverse for being used for propaganda and institutional control. Other authors have highlighted concerns regarding the scalability and interoperability of the metaverse due to the large amount of data this technology stores (Wang et al., 2022).

In order to understand better the progress made in research on metaverse and how to approach future research studies in this area, we propose a literature review. This work complements other reviews such as the one by Systematic Literature Review on the Use of Metaverse in Education. This article aims to give a broader view, synthesizing the advances achieved regarding metaverse as a technological innovation in the educational context and identifying the main research avenues. Our work extends the analyzed

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time interval by adding documents published from 2017 to 2022, which might be valuable as researchers have increased their attention in this area in the last years. Our work also presents the exploratory approaches in addition to the emerging potential of the metaverse in education such as gamification but also considering the advantages and limitations.

RESEARCH QUESTIONS

This work is dedicated to reviewing the existing literature on the application of the metaverse in education. Our objective is to propose future lines of research in this rapidly evolving field. This section outlines our motivation and introduces the key research questions (RQs) that guide our study.

RQ1: What are the Main Advancements and Advantages of Using the Metaverse in the Field of Education?

The objective of this RQ1 is to explore and document the recent developments in the metaverse as applied to education. This RQ1 seeks to understand how the metaverse is reshaping educational methodologies and the specific benefits it offers to students and educators.

RQ2: What are the Requirements and Limitations for the Use of the Metaverse in the Field of Education?

The objective of this RQ2 is to identify and analyze the prerequisites for implementing the metaverse in educational settings and the challenges that may arise. This inquiry delves into the practical aspects of metaverse

integration, including technical needs, resource allocation, and potential obstacles. Understanding these elements is crucial for developing effective strategies to leverage the metaverse in enhancing educational experiences.

METHODOLOGY

Our search was conducted on Scopus, Web of Science, SciELO and Redalyc repositories, using the keywords "metaverse" and "education" in both English and Spanish ("metaverso" and "educación", respectively). We selected only those results that contained both terms, without any language restrictions. To ensure transparency and quality, in the article selection process, we meticulously followed specific criteria to guide our selection, employing the following steps.

Inclusion criteria:

- Articles published in scientific journals indexed in recognized databases;

- Original scientific articles published between 2017 and 2022 (new research area);

- Scientific articles that include perspectives about the metaverse and its educational use.

Exclusion criteria:

- Articles published in non-indexed journals;

- Undergraduate, postgraduate, or Master theses;

- Articles published in 2017 or prior,

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following the recommendations of the ISO 11620 for systematic reviews;

- Articles exclusively focused on the metaverse, without considering the educational field.

RESULTS

RQ1: What are the Main Advancements and Advantages of Using the Metaverse in the Field of Education?

GAMIFICATION AND THE METAVERSE IN THE EDUCATIONAL FIELD

Educational games. This combination of technologies also awakens interest and curiosity promoting learning (Chen, 2022).

The successful implementation of gamification in the educational realm is often associated with an increase in knowledge retention and student engagement. Furthermore, the use of gamification in virtual environments, such as the metaverse, has gained interest due to its ability to create more immersive and collaborative educational experiences (Afacan, 2023). Some of the works reviewed (n=6) mention the concept of gamification, that is, the use of strategies oriented towards promoting learning, thanks to the educational elements present in games, which have been implemented for a decade (Contreras Espinosa, 2016). Gamification increases the compromise and the interaction of the student during online courses (Jovanovic & Milosavljevic, 2022). However, gamification now seems to require immersion in the virtual

world (Gallastegui, 2018; Hwang & Chien, 2022; Park & Kim, 2022).

Gamification can be exploited in any of the two immersive levels of the metaverse: (1) interaction, and (2) representation, and may be incorporated to improve student motivation, which may as well lead to more effective learning and better long-term knowledge retention (Gallastegui, 2018). With the help of technologies such as VR, AR, AI, brain-computer interfaces (BCIs), and IoT (the Internet of Things), gamified learning, supported by metaverse-based education, can be construed as an educational method that employs immersive games as the main means to integrate knowledge and entertainment for a genuine enjoyment of the learning process (Park & Kim, 2022). Teachers may use VR and AR to combine game-based learning efforts, promoting learning through interactive simulations and the practice of skills in controlled environments. Classrooms (physical and virtual) become more vibrant when including.

ADVANTAGES OF THE USE OF THE METAVERSE IN EDUCATION

Several authors (n=17) mention the advantages of the use of the metaverse for educational purposes. In the metaverse, common standards are demolished, and individuals can create avatars that represent them as they are in the real world, but also depict them as any animal or creature they feel identified or represented by (Oliva & Ríos, 2022; Villarreal & Pereira, 2021). While students immerse themselves in an immersive

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environment, they have the opportunity to experiment with different roles and characters (Hwang & Chien, 2022). This experience can improve their ability to empathize and understand different perspectives, which can in turn enhance their individual and social skills in learning (Kocur et al., 2020). In addition, immersion in a virtual environment can foster greater freedom of expression and creativity in the learning process.

In traditional learning and training, students and learners often receive information passively (Xi et al., 2023), which can limit their ability to process and retain it. Additionally, this may require greater cognitive effort on the part of the student. In contrast, in the metaverse, students can interact actively with the environment and information (Na et al., 2022), which can enhance their ability to retain and comprehend it more deeply.

Instead of a static picture, each user in the metaverse may create his or her own unique digital identity in the form of an avatar. The development of the digital identity is more customized by users and advanced than before; for example, it may alter the specifics of the avatar's face, physique, and even facial expression (Kocur et al., 2020). It is the virtual surrogate identity of users that reflects the user's persona and symbolizes the ego in the actual world. Avatars may also be modified and controlled by users using real-time tracking technology. In this situation, the live 3D representation of users (i.e., virtual identity) is vital in the metaverse environment for ownership, engagement, embodiment, and sociability. This identification can develop a better use of the education in the metaverse.

Furthermore, the use of 3D images seems to promote immersion, previously reported in the fields of Anatomy (Menezes et al., 2019; Ramesh et al., 2022), Environmental learning (Lo & Tsai, 2022), Engineering (Ochoa & Ortíz, 2018), ophthalmology (Tan et al, 2022) and Nursing (Zhao et al., 2022). Recent study by Dwivedi et al. (2022), the use of the metaverse in education can contribute to cost reduction, improve the efficiency of educational programs, enhance efficiency and students' interest in learning (Chen, 2022), allowing for greater access to underserved populations (Ahuja et al., 2023). Immersion in virtual spaces may be more attractive and accessible for the new generations, who grew up surrounded by technology. This may open new opportunities for education and learning (Zhang et al., 2022), as well as for new educational and economic models. Lastly, Garzón (2022) mentions that the interest in the use of the metaverse in the educational field is growing, as shown by the increasing amount of content creation and viewing in relation to this topic on other platforms, such as YouTube.

RQ2: What are the Requirements and Limitations for the Use of the Metaverse in the Field of Education?

REQUIREMENTS FOR THE USE OF THE METAVERSE IN EDUCATION

Wireless communication and networks with great speeds, such as 5G or 6G, are key prerequisites for the deployment and operation of the metaverse world, according to academics (Dwivedi et al., 2021; Kye et al., 2021), thus the metaverse can maintain fluency, stability, and

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low latency for data transfer, scene display, instant feedback, and user connection with the use of high-speed networks. On the other hand, high-speed networks enable learners to smoothly transition from the physical world to metaverse instructional settings.

Because the metaverse is a multi-player space, computing methods (edge computing, cloud computing, distributed computing) are required to manage, analyze, store, share, and exchange data and information between the virtual world and the real world, as well as among users (Zhang et al., 2022). In this situation, these technologies can assist learners in more correctly, efficiently, and synchronously storing, utilizing, and sharing learning data (learner information, learning records, learning materials).

On the other hand, according to Thohir et al. (2023), the use of simple strategies in the teaching-learning process with this technology shows a positive relationship. This includes the way we give a class and the learning resources. This finding is logical since at the beginning of the introduction of a new technology, basic functions are usually used. In fact, this can be observed in old video games, which probably differ from those created today.

LIMITATIONS FOR THE USE OF THE METAVERSE IN EDUCATION

Some works (n=13) mention a certain set of limitations or characteristics that may affect the implementation of metaverse-based education. It is widely accepted that one of the general characteristics of the metaverse is that it breaks down the barrier between what

is real and what is digital, theoretically leading to a unique and indivisible world (Inceoglu & Ciloglugil, 2022). Among the problems the use of the metaverse may encounter in the educational field, some authors highlight the interference between the AI and the figure of the teacher (Dwivedi et al., 2022; Chen, 2022), progressively making the role of the latter somewhat irrelevant and unnecessary, as AI is updated with programming and evolves and learns by itself (Hwang & Chien, 2022; Mejía, et al., 2022), and is thus able to update and produce content and activities in a faster and more efficient manner. Other authors (Falchuk et al., 2018) remark on the privacy loss issue, both due to the direct publication of user data and the mere individual presence in the virtual world. On the other hand, the commonly used equipment can cause dizziness, nausea, motion sickness and eye strain (Lo & Tsai, 2022).

The privacy and data security of users, whether on the 2D Internet or in the 3D virtual world, is of vital concern. Data is the core form of governance in the metaverse, allowing for the collection of more specific data from users, such as face photographs, physical status (heart rate, blood pressure, illness, etc.), transactions, consumption records, and so on (Kye et al., 2021; Zhang et al., 2022). Furthermore, because of the metaverse's heightened level of online anonymity, learners with limited social experience are more easily exposed to illegal activities (fraud, spying, leaking). Once this occurs, it will infringe on the learners' privacy and may drastically disrupt their daily lives.

Furthermore, both instructors' and

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students' efforts and innovations have the potential to be plagiarized. In this regard, related regulations and laws (Seok-hwan & Seok-hwan, 2022) (real-name authentication) are expected to be implemented, and regulators who serve in the same capacity as police in the real world are desperately needed; additionally, it is essential to make the works and creations in the metaverse traceable using technologies such as cryptocurrency, NFT, and blockchain (Zhang et al., 2022). Otherwise, the metaverse will evolve into a lawless digital realm.

Currently, teachers do not know about the extension and application of the metaverse (Kim et al., 2021). So, professional development of teachers in respect to the metaverse is needed. It is often assumed that instructors play a critical role in successful education and educational change (Kye et al., 2021). The metaverse, as an emergent educational technology, has the potential to give several opportunities for instructors. To that purpose, preparing instructors to teach using the metaverse is a complicated and multifaceted endeavor (Menezes et al., 2019; Hwang & Chien, 2022). Furthermore, the presence of the metaverse results in new appearances for teacher education held in a completely new virtual area. As a result, teacher education and professional growth may become critical topics in metaverse educational research.

An additional limitation of the metaverse is the lack of multisensory experience, which restricts the user's ability to perceive a more realistic experience that involves multiple senses simultaneously (Xi et al., 2023). For instance, the absence of sound and tactile experience when moving and interacting with virtual objects can affect the user's perception of being immersed in the virtual environment and diminish the sense of realism. To achieve complete immersion, advanced technologies such as haptics and brain-computer interfaces are needed. Therefore, it is important for companies to invest in the research and development of the technologies that are fundamental to the operation of the metaverse (Sá & Serpa, 2023).

LEARNED LESSONS

The perception of games and their relationship with learning have evolved with time (Contreras Espinosa, 2016). Games now include certain characteristics, such as the type of content, and the personal and immersive experiences (Gallastegui, 2018), that contribute to a new view of gamification as an effective and immersive educational strategy (Dwivedi et al., 2022) that increases the compromise and interaction level of students (Jovanovic & Milosavljevic, 2022) and improves motivation, leading to more effective learning and knowledge retention. In contrast, one potential disadvantage is that game-based learning may not always provide a fully realistic simulation of real-world scenarios (Álvarez et al., 2022). While games can simulate some aspects of a situation, they may not accurately capture all the variables or nuances of a real-world scenario (Hurtado, et al., 2022). This can limit the effectiveness of game-based learning in preparing students for real-life situations. (Gallastegui, 2018). By allowing students to participate in an active community and experience an enriching virtual

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culture, game-based learning may provide a unique and effective educational experience (Contreras Espinosa, 2016), which creates a secure and low-risk setting for students to try new activities and make errors, enabling them to learn from their mistakes without the worry of negative outcomes. As a result, boost their self-assurance and drive, leading to improved learning achievements. Immersion in the virtual world represents the natural next step of gamification in the educational field (Gallastegui, 2018; Hwang & Chien, 2022; Park & Kim, 2022) and the metaverse is a key tool to this end, favored by the current technological convergence (Park & Kim, 2022). This synergy would render the integration of knowledge and entertainment (Park & Kim, 2022) and lead to more vibrant learning environments that promote interest and curiosity (Chen, 2022).

The metaverse represents an advance in the field of education and has proven to be superior to this end than traditional media such as television or cinema (Inceoglu & Ciloglugil, 2022). Allowing individuals to interact and explore a virtual world in the first person through an avatar (Oliva & Ríos, 2022; Villarreal & Pereira, 2021) instead of merely looking at a screen creates a more immersive experience and allows experimentation with different roles (Hwang & Chien, 2022), which may translate into an increase in the ability to empathize with and understand others and promotes freedom of expression and creativity while learning. The immersion level the metaverse offers in a conceptual and semiotic world beyond what is possible with any other technology, providing individuals with a feeling of presence and connection with other users in a real and exciting manner. When applied to education (Menezes

et al., 2019; Ochoa & Ortíz, 2018; Garzón, 2022), this first-person experience has been shown to increase the comprehensive abilities of students (Dwivedi et al., 2022). Furthermore, it is important to note that game-based learning may not be suitable for all learning objectives and subjects. While it can be an effective tool for imparting certain skills and concepts, it may not be the most suitable approach for other subjects or learning objectives (Caicedo, 2022). In addition, metaverse-based education may reduce costs and improve the efficiency of education, as it will eventually become more accepted, widespread, and accessible (Dwivedi et al., 2022).

In turn, the metaverse has made it possible to combine objects of study as diverse as anatomy and engineering, since it is proposed that these objects of study can be seen from a new perspective of immersive reality in which students can learn with greater interaction and implementation of projects that could be more complex in the real world (Kye et al., 2021). That is to say, the study of these areas and others can be seen, based on projects and constructions that involve the vision of diseases around pathological anatomy (Tan et al., 2022; Ramesh et al., 2022). In the case of nursing, for example, the ideal sites for injection and its form are presented (Zhao et al., 2022). That is, depending on the area of study, its application varies to help in practice without adding risks such as initial experimentation with patients.

As suggested by Akour et al. (2022), the effectiveness of the metaverse as an educational tool resides in its interactive elements and the personalized user experience.

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We believe that the possibility to create immersive and personalized environments in the metaverse also offers more flexibility for the implementation of gamification both inside and outside the classroom, allowing adaptation to the student´s individual needs and preferences thanks to AI. Altogether, the combination of the metaverse and gamification may be promising and revolutionary for the future of the educational field and seems to be a logical step in the development of educational technology.

As an example of the growing interest in educational video games, it is noteworthy to mention Roblox. To increase its reach within the educational field, the company invested USD 10 million to develop three educational games focused on robotics, space exploration, IT, biomedical science, and engineering which will be distributed for free in schools in several countries (Dean, 2022). Given the current trend, it is likely that, in the next years, we will observe an increase in the use of educational games and platforms, and a growing interest in the use of metaverses for education (Garzón, 2022).

It should be noted that game-based learning may not be within reach or economical for all students, particularly those who come from low-income or underprivileged backgrounds (Hurtado, et al., 2022). Developing and implementing game-based learning programs can be very costly, and not all students may have access to the technology or equipment required to participate. Building a metaverse, regardless of whether for educational purposes or not, entails challenges (Falchuk et al., 2018). Besides the general ethical concerns regarding the metaverse highlighted by Molina (2022), there are current challenges in relation to sustainability, security, and safety (Dwivedi et al., 2022), and a lack of adequate technological support (Wiederhold, 2022). For a metaverse to truly replicate the real world, existing technology would require significant upgrades in the areas of cloud computing, AI, and powerful networks (Wiederhold, 2022). Users require low-cost lightweight equipment to interact in a continuous manner with the metaverse and immerse themselves in high-resolution digital information. These technologies and devices are expensive and difficult to obtain in large enough quantities and become a limiting factor both for designers and users (Park & Kim, 2022). VR headsets, a must-have device, are usually expensive, with a range from USD 400 in the case of the Meta Quest 2 model, to USD 1100 in the case of Meta Quest Pro, without considering accessories (prices verified in January 2023). However, it is important to consider that, as it happened with the popularization of other technologies such as mobile phones, as the metaverse becomes more accessible, the prices of these devices may also experience a price reduction and become more accessible to the public; several companies are already working towards creating cheaper options.

This review has allowed us to identify two new key barriers affecting the use of the metaverse in the educational field: (1) the interference between the teacher and the AI and (2) privacy loss. AI may represent a threat to the role of the teacher due to its efficiency and the ability to autonomously learn and personalize content depending on the student´s needs, which may render the

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teacher´s role irrelevant or eventually even unnecessary (Dwivedi et al., 2022; Chen, 2022; Hwang & Chien, 2022; Mejía et al., 2022). Nevertheless, from a constructivist point of view, the direct interaction of students 24/7 with an artificial agent may be valuable for the educational process. It may even surpass traditional teachers and improve the efficiency of learning, and mutual help among users through consistent interaction may help them overcome their doubts while studying. On the other hand, loss of privacy is a significant concern about the metaverse, as users may be exposed to monitoring without their consent (Falchuk et al., 2018) by the owners of the platform or third parties. Therefore, as this technology advances, it would be crucial to study and evaluate its effect on society and put measures in place to avoid undesirable impacts.

Considering the current situation, it's crucial to explore the potential learning opportunities provided by the metaverse and to develop new curricula based on it. Historically, the educational field has successfully adapted to technological advances, such as the printing press, books, and the internet. As the metaverse becomes more accessible and popular, it's likely that the educational field will also adapt to this new technology. However, there are some challenges to overcome, including stable infrastructure, interconnectivity of applications, user security and privacy, and device costs. Once these obstacles are addressed, the potential for the metaverse to transform education is vast (Wiederhold, 2022; Dwivedi et al., 2022; Park & Kim, 2022).

CONCLUSIONS

The metaverse holds a great potential for revolutionizing the way we approach education. It offers new ways of teaching and learning that are more immersive, engaging, motivating and personalized. However, there are several crucial matters that need to be addressed before metaverse-based education can become a reality. Technological advances are needed to ensure that the metaverse is accessible to all learners and that it can provide a seamless and high-quality learning experience. Two key concerns regarding the implementation of metaverse technology for educational purposes are the potential interference between AI and the role of the teacher, and the risk of privacy loss, especially for underage students. Further research is needed to better understand these issues and develop effective strategies to address them. An acceptability study among teachers and students can also provide valuable insights into the potential and utility of the metaverse within the educational field. In conclusion, while the metaverse holds great promise for the future of education, it is important to approach its development with caution and care, considering the potential risks and challenges as well as the opportunities for innovation and improvement.

The metaverse is a digital place that is more open, shared, and decentralized than typical virtual spaces. It indicates that in the metaverse, the storage of learners' information should be handled and protected in the same way that other apps placed on the cloud today with highly secure standards to prevent violating users' privacy (utilize user

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authentication and authorization to specify the delivered material). Furthermore, users' virtual works or digital inventions may be shared with others, with the expectation that they will be traceable and safeguarded. Blockchain and NFT (non-fungible token) technologies allow learners' contributions or works to be validated and traceable, aiming to maintain the metaverse world secure, permanent, and sustainable.

The effective integration of gamification in education has demonstrated a positive correlation with heightened knowledge retention and increased student engagement (Afacan, 2023). The growing interest in applying gamification to virtual environments, particularly within the metaverse, is driven by its capacity to cultivate more immersive and collaborative educational experiences.

Certain crucial matters are currently hindering the development of metaverse-based education, including the need for technological advances, accessibility problems, and other ethical issues pertaining to the metaverse in general, such as escapism or addiction, among others. We identified two key concerns regarding the implementation of metaverse technology for educational purposes. First, the interference between AI and the role of the teacher and, second, privacy loss; issues that need to be properly studied through further research and addressed before this new educational paradigm is deployed, especially considering the impact it may have on underage students. Additionally, since the metaverse is a new technology, further research may focus on its definition and evaluation of the potential dangers and pertinent mitigation strategies.

Last, it would be paramount to conduct an acceptability study among teachers and students in order to better determine its potential and utility within the educational field.

However, we believe that the development of metaverse technology provides society with a new sense of imagination, and its possible applications in the educational field will revolutionize how education is delivered, improve the efficacy of both teaching and learning, and open a new world of opportunities and perspectives for students, educators, and the educational sector through more immersive experiences. On the other hand, to make a better development on the impact of the metaverse in education, the hardware must be adapted and developed to reduce all kinds of risks associated with it, such as nausea, headache, motion sickness and eye strained.

The ability to experience occurrences that would be impossible or limited in the actual world is an effective and appealing element of the metaverse. However, rather than students' cognitive skills and imagination, there is space for blindly embracing the goals of content producers or service designers. As a result, educational designers and teachers who want to use the metaverse for education must first grasp the technological features of each type of metaverse and then create courses that allow them to solve issues or complete tasks collectively and imaginatively. It is also necessary to create an instructional metaverse platform to avoid the misuse of pupil data. Data collection evaluation studies to help instruction and learning are also needed.

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Another recommendation would be that metaverse should create structures or systems for educational use. At this point, the metaverse is under development, and it necessitates high-quality infrastructure that is adaptable to common activities. The metaverse's designs and frameworks, which include both hardware and software, serve as the foundation for educational processes. Multiple variables, including as accessibility, security, humanity, trust, educational capacity, and learners' cognitive qualities, are seen to be important in the construction of the metaverse for school administrators, instructors, and learners. Furthermore, greater effort should be put into unusual and extra design aspects for education. For instance, a certain setting may allow one learner avatar to "airdrop class notes" to another student avatar.

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